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ORIGINAL RESEARCH

THORACOLUMBAR RANGE OF MOTION IN BASEBALL PITCHERS AND POSITION PLAYERS

Kevin Laudner, PhD, ATC[1]
Robert Lynall[2]
Jeffrey G. Williams, MS, ATC[1]
Regan Wong, PT[3]
Takashi Onuki, MS, ATC, CSCS[4]
Keith Meister, MD[3,5]

ABSTRACT

Introduction/Background: Optimal baseball throwing mechanics require a significant contribution of thoracolumbar motion, particularly in the sagittal and transverse planes. This motion is key for proper transmission of forces from the lower to upper extremity, thereby minimizing a throwing athlete's risk of injury and maximizing athletic performance.

Purpose: To define the active-assisted thoracolumbar ROM of both baseball pitchers and position players and to compare these motions both within and between groups.

Methods: Fifty-six asymptomatic, collegiate and minor league baseball pitchers and 42 position players volunteered to participate. Active-assisted thoracolumbar flexion, extension, and bilateral rotation ROM, were measured in a standing position, using two bubble inclinometers. Two-tailed *t* tests were used to determine differences in ROM between and within the pitchers and position players.

Results: The pitchers had significantly more rotation to the non-throwing arm side as compared to the position players (p = .007, effect size = .61). The pitchers also had more rotation to the non-throwing arm side as compared to their throwing side (p = .006, effect size = .47). There were no other significant differences between the pitchers and the position players (p > .53). Furthermore, the position players did not have a side-to-side rotation difference (p = .99).

Conclusions: Pitchers have a greater amount of rotation ROM towards the non-throwing arm side as compared to position players. Pitchers also have a greater amount of rotation ROM to the non-throwing arm side as compared to their throwing side rotation. Because pitchers often present with posterior shoulder tightness and subsequent altered shoulder horizontal adduction and internal rotation ROM, the increase in non-throwing side rotation ROM may occur in response to these adaptations. More specifically, this increase in non-throwing side trunk rotation ROM may allow such athletes to bring the arm across the body during the follow-through phase of the throwing motion despite posterior shoulder tightness. However, future research is necessary to investigate this relationship. Based on these results, clinicians should consider these thoracolumbar ROM adaptations in the prevention, evaluation, and treatment of baseball players.

Level of Evidence: 2b

Key Words: Flexibility, spine, throwing athlete, trunk.

[1] Illinois State University, Normal, IL, USA
[2] University of North Carolina, Chapel Hill, USA
[3] Texas Metroplex Institute for Sports Medicine and Orthopedics, Arlington, TX, USA
[4] Arizona Diamondbacks Baseball Organization, Phoenix, AZ, USA
[5] Texas Rangers Baseball Organization, Arlington, TX, USA

CORRESPONDING AUTHOR

Kevin Laudner, PhD, ATC
Phone: 1-309-438-5197
Fax: 1-309-438-5559
Email: klaudner@ilstu.edu

INTRODUCTION

The throwing motion requires a very complex series of movements involving the lower and upper extremity, as well as the spine. Proper motion at the trunk is critical to the transfer of kinetic energy from the lower extremity to the upper extremity during the throwing motion.[1,2] Typically, the legs and trunk act as force generators while the upper extremity regulates this force through the shoulder complex, elbow, and hand as force is delivered to the ball.[2,3] Kibler and Livingston[4] have reported that the legs and trunk provide a stable base for arm motion, as well as the the generation of kinetic energy during the throwing motion. However, before this exchange of forces can occur, the spine must have an appropriate amount of movement in order to allow for proper transfer of the kinetic energy. More specifically, optimal baseball throwing mechanics require a significant contribution of thoracolumbar motion, particularly in the sagittal and transverse planes.[3,5-7]

Throughout the throwing phases the thoracolumbar spine goes through various motions. More specifically, during the wind up the trunk rotates towards the throwing-arm side and maintains this position until the lead leg makes contact with ground as the body strides towards the intended target.[8] Just after maximum glenohumeral external rotation, or the late cocking position, the body begins to uncoil and transfer all of its energy in the legs, trunk, and upper extremity forward during the acceleration phase.[8] At this time the trunk flexes[9] and rotates back towards the non-throwing side in order to transfer this kinetic energy towards the intended target.[8]

Previous investigators have shown the importance of proper specific movement patterns,[10-13] as well as trunk strength[5] and range of motion (ROM)[5,14] in relationship to both athletic performance and injury prevention. Although, authors have clinically investigated the characteristics of spine ROM among different athletes,[15,16] no data are currently available for baseball players. This is concerning considering a study conducted from 2002-2008 that showed 12% of all injuries among Major League Baseball players occur to the spine and core.[17] Furthermore, pitchers were reported to have a 34% higher incidence of injury than position players, such as infielders and outfielders. Therefore, not only is it important to have normative trunk ROM values for baseball players, but it is conceivable that pitchers and position players may have some differences in trunk ROM.

The purpose of this study was to define the active-assisted thoracolumbar ROM of both baseball pitchers and position players and to compare these motions both within and between groups. It was hypothesized that pitchers would have greater rotation to the throwing arm side compared to their non-throwing arm side. The authors also speculated that the pitchers would have greater overall trunk ROM than position players. Because of the importance of proper trunk motion during an overhead throw and the subsequent injury that can occur to the core of such athletes, these descriptive ROM characteristics may be clinically beneficial. Such information may provide clinicians with insight into common trunk ROM adaptations among baseball players that could be used in the prevention, evaluation, and treatment of various trunk injuries or other pathologies associated with decreased trunk ROM.

METHODS

Participants included 56 collegiate and minor league baseball pitchers (age = 22.1 $\pm$ 2.2 years, height = 188.7 $\pm$ 5.7 cm, mass = 87.5 $\pm$ 8.7 kg) (43 right handers, 13 left handers) and 42 position players (age = 22.8 $\pm$ 4.4 years, height = 184.2 $\pm$ 5.3 cm, mass = 86.4 $\pm$ 7.7 kg) (37 right handers, 5 left handers). All participants had no recent history (within the past 2 years) of trunk or core pathology or any previous surgery.

Prior to participation, each volunteer provided informed consent as approved by the university institutional review board. All participants reported to the athletic training room for one testing session preceding their scheduled throwing or strength and conditioning program. Thoracolumbar flexion, extension, and bilateral rotation active assisted ROM were measured by three investigators (one physical therapist, two athletic trainers). All ROM measurements were performed in a randomized order and adapted from those proposed by Clarkson.[18]

To measure thoracolumbar flexion, each participant stood with their feet shoulder width apart, arms crossed over their chest, and knees in slight flexion. In this position, one examiner placed a bubble inclinometer (Fabrication Enterprises Inc. White Plains, NY) vertically over the spinous process of C7 while the other examiner placed a second bubble inclinometer vertically over the spinous process of S2 (Figure 1). A third examiner then actively-assisted each participant into their end range of flexion motion. The end ROM was defined as the first point of tissue resistance felt by the investigator, without the addition of overpressure. At this end range position, each examiner holding a bubble inclinometer recorded the amount of movement in degrees achieved in the sagittal plane. The difference between the two inclinometers was determined to be the available amount of thoracolumbar flexion ROM. Thoracolumbar extension was measured in a similar fashion, but with the participants' hands resting on their iliac crests and being passively moved into end range of trunk extension. A priori pilot reliability of these techniques have shown good intraclass correlation coefficients for flexion and extension of .82 and .87 respectively. Furthermore, the authors standard error of measurement for flexion and extension were 1.8° and 3.1°.

Figure 1. *Placement of bubble inclinometers on the spinous processes of C7 and S2 for flexion and extension range of motion measurements.*

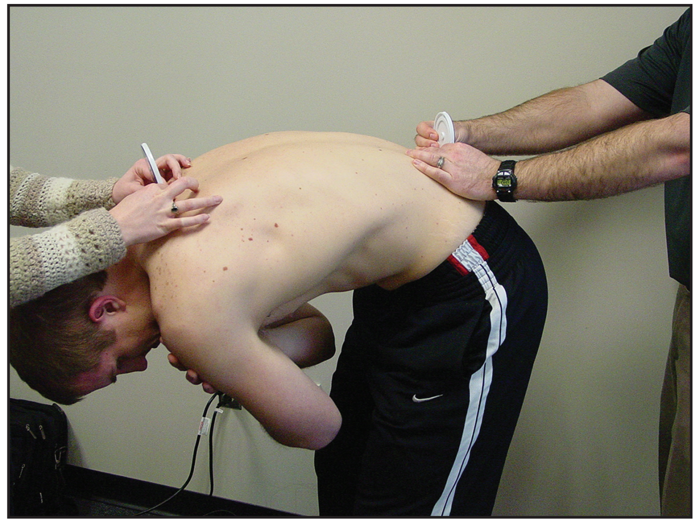

Figure 2. *Placement of bubble inclinometers on the spinous processes of C7 and S2 for rotation measurements.*

For the measurement of thoracolumbar rotation, each participant was positioned with their feet shoulder width apart, arms crossed over their chest, knees in slight flexion, and the trunk flexed to 90°. One examiner placed a bubble inclinometer horizontally over the spinous process of C7 while the other examiner placed a second bubble inclinometer horizontally over the spinous process of S2 (Figure 2). A third examiner then actively-assisted each participant into end range of rotation motion by applying pressure to the posterior shoulders. At the end ROM, both examiners took a reading from their respective inclinometers. To determine thoracolumbar rotation ROM, the S2 measurement was subtracted from the C7 measurement. This procedure was completed for rotation ROM to each participant's throwing arm side and non-throwing arm side. A priori pilot reliability of this technique has shown a good intraclass correlation coefficient of .84. Furthermore, the authors' standard error of measurement for rotation was 6.4°.

Separate 2-tailed *t* tests (PASW software, Version 18.0, IBM Corp, Somers, NY) were used to determine if any differences existed between and within the pitchers and position players. Dependent variables included thoracolumbar flexion, extension, and rotation ROM to the throwing arm and non-throwing arm sides between groups, as well as bilateral rotation within each group. Because multiple t-tests were utilized by the investigators, α1 was adjusted using a standard version Bonferroni correction (P = .05/6, or P = .008) to protect against type I error. To compare the sensitivity of differences in thoracolumbar rotation ROM, effect sizes were determined. Effect size for between group variables were calculated as: (position player group mean – pitcher group mean)/standard deviation. The effect size for within group rotation was calculated as: (rotation to throwing arm side group mean – rotation to non-throwing arm side group mean)/standard deviation.[19]

RESULTS

The means and standard deviations among the pitchers and position players for thoracolumbar flexion, extension, rotation to throwing side, and rotation to non-throwing side ROM are shown in Table 1. The pitchers had significantly more rotation to the non-throwing side compared to the position players (4.2°) (p = .007, effect size = .61) (Figure 3). The pitchers also had more rotation to the non-throwing side compared to their throwing side (3.1°) (p = .006, effect size = .47) (Figure 4). There were no other significant differences between the pitchers and the position players (p > .53). Furthermore, the position players did not have a side-to-side rotation ROM difference (p = .99).

DISCUSSION

Due to the accumulation of forces placed on the trunk throughout the throwing motion,[3] clinicians need to understand the normative ROM values for

Table 1. *Descriptive Statistics for Thoracolumbar Range of Motion Characteristics (°)[a].*

Measurement	Pitchers	Position Players	AMA Data[29]
Flexion	54.9 ± 20.4	54.0 ± 16.8	0 – 60
Extension	44.0 ± 17.0	43.6 ± 16.2	0 – 25
Rot to Throwing Arm Side	48.8 ± 6.4	47.9 ± 7.2	1 – 30
Rot to Non-Throwing Arm Side	51.9 ± 6.6	47.7 ± 6.9	1 – 30

Rot = rotation; AMA Data= Reference values from the American Medical Association.
[a]Values are reported as mean ± standard deviation in degrees (°).

Figure 3. *Thoracolumbar range of motion among the pitcher and position player groups. *Significantly more thoracolumbar rotation range of motion to the non-throwing arm side was seen among pitchers compared with position players (P = .007).*

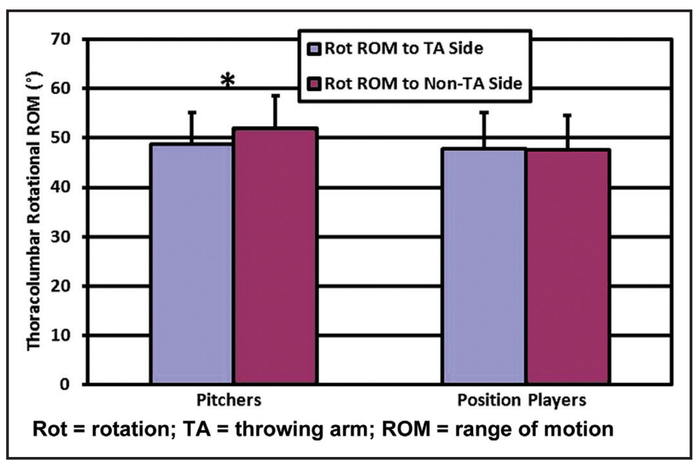

Figure 4. *Thoracolumbar rotational range of motion to the throwing and non-throwing arm sides of pitchers and position players. *Significantly more thoracolumbar rotation range of motion to the non-throwing arm side compared to the throwing arm side among pitchers (P = .006).*

baseball players in order to evaluate and treat such athletes. The authors of this study hypothesize that because of the potential for different loads accumulated between pitchers and position players, disparities in trunk ROM may exist between these players. However, the hypotheses for differences between pitchers and position players for thoracolumbar flexion and extension were not supported. These findings may not be surprising for some considering the relatively small amount of trunk flexion/extension forces created during the throwing motion on flat ground.[3] Regardless, because several spine disorders including disc herniations,[20,21] spondylolysis,[22] and intervertebral disc degeneration,[23] have been reported among baseball players the described ROM values may be beneficial for clinicians. More specifically, the described thoracolumbar flexion and extension ROM values can be used by clinicians in the prevention, evaluation, and treatment of various spine pathologies and injuries associated with trunk ROM deficits among throwing athletes.

Typical clinical ROM measurements are made based on the assumption that patients have equal motion bilaterally. However, based on the extensive amount of researchers that has reported bilateral differences at various joints in baseball players[24-27] it is necessary to determine if such bilateral differences exist in spine rotation as well. The hypotheses for differences within and between groups were supported. More specifically, the current results indicate that pitchers have more rotation ROM to the non-throwing arm side as compared to their throwing arm side and more non-throwing arm side rotation ROM compared to that of position players. Although these differences in rotational ROM reflect moderate effect sizes (between group effect size = .61; within group effect size = .47),[19] the fact that the differences in ROM are smaller than the standard error of measurement call their clinical significance into question. Regardless, this increased amount of rotation to the non-throwing arm side among pitchers may be an adaptation to allow for a full follow-through position despite subsequent glenohumeral ROM deficiencies, such as horizontal adduction and internal rotation. Past studies have shown that there is an increased amount of posterior shoulder tightness among pitchers compared to position players.[24,25] This tightness may restrict the available amount of glenohumeral internal rotation and horizontal adduction ROM.[28] As such, the additional amount of trunk rotational ROM to non-throwing arm side found in pitchers may be a chronic adaptation developed to allow the arm to come across the body during the follow-through phase of the throwing motion in the presence of altered glenohumeral motion. However, future research is necessary to investigate this relationship. Based on the current results, clinicians should consider these thoracolumbar adaptations in the prevention, evaluation, and treatment of baseball players.

To the authors' knowledge, these are the first such thoracic active assisted ROM measurements taken of a healthy sample of baseball players. When comparing the current results to normative data for passive trunk motion put forth by The American Medical Association (AMA),[29] baseball players appeared to have larger amounts of ROM for several trunk motions. More specifically, the pitchers and position players in the current study both presented with greater active trunk extension, rotation to the throwing arm side, and rotation to the non-throwing arm side than the normative data (Table 1). However, both the pitchers and position players had trunk flexion values that fell within the AMA standards (Table 1). These larger values for trunk extension and bilateral rotation suggest that asymptomatic baseball players may have adaptations in trunk ROM; however, future research is needed in this area for confirmation.

Several limitations exist in the current study. The sample consisted of collegiate and minor league baseball players, therefore, the findings may not be applicable to baseball players of different experience levels or other overhead athletes, such as softball, tennis, and volleyball players. The values reported provide the combined ROM available in the thoracic and lumbar spine regions. Therefore, ROM for specific regions of the spine cannot be assumed from these results. Future studies should address any relationships that may exist between trunk ROM and ROM at subsequent joints such as the hip, shoulder, and elbow. Longitudinal studies are also needed to investigate if alterations in these trunk ROM values have any effect on the incidence of injury to the trunk, lower extremity, or upper extremity among baseball players.

CONCLUSIONS

This study is the first to report clinical thoracolumbar extension, flexion, and bilateral rotation active assisted ROM values among baseball pitchers and position players. Pitchers had a greater amount of trunk rotation ROM to the non-throwing arm side compared to their throwing arm side (3.1°). The pitchers also had more trunk rotation ROM to the non-throwing side compared to the position players (4.2°). These results suggest that different forces may be imparted at the trunk of pitchers and position players. Furthermore, the increased amount of rotation found in pitchers may be adaptations developed to compensate for ROM deficits at subsequent joints; however future research is necessary to investigate this hypothesis. An understanding of trunk ROM values in both asymptomatic pitchers and position players may help clinicians to detect inadequacies and provide appropriate preventive and treatment interventions for various injuries among baseball players.

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